MEMS Metrology

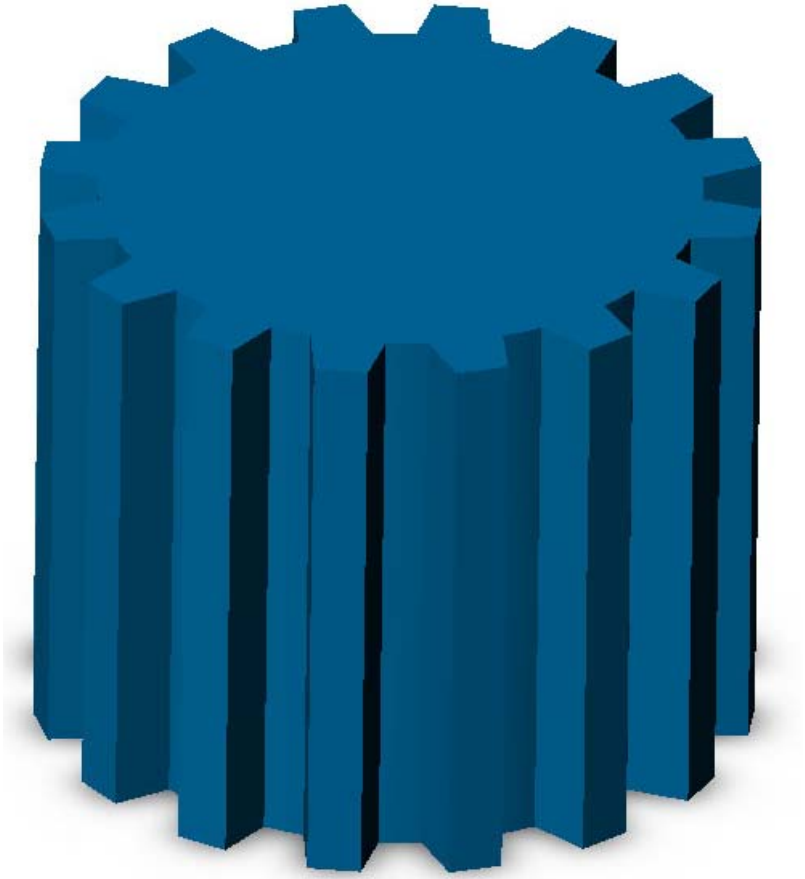
Presented by James Nichols
Advisor: Dr. Thomas Kurfess
October 29, 2002

Overview

- Background information
- Current problems
- Objectives of research
- Expected Contributions

Background

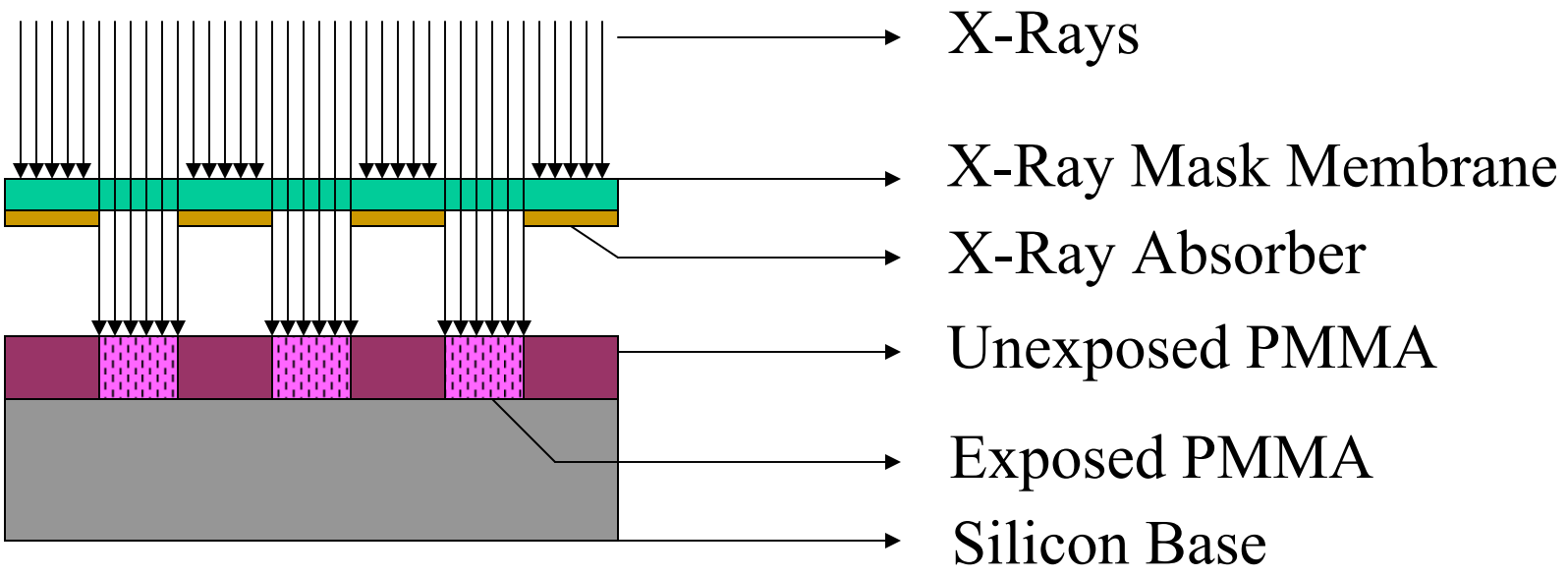
- LIGA
  - German acronym for lithography (lithographie), electrodeposition (galvanoformung), and molding (abformtechnik)
  - Fabrication method used to manufacture high-aspect ratio MEMS (micro-electro-mechanical systems)



Background

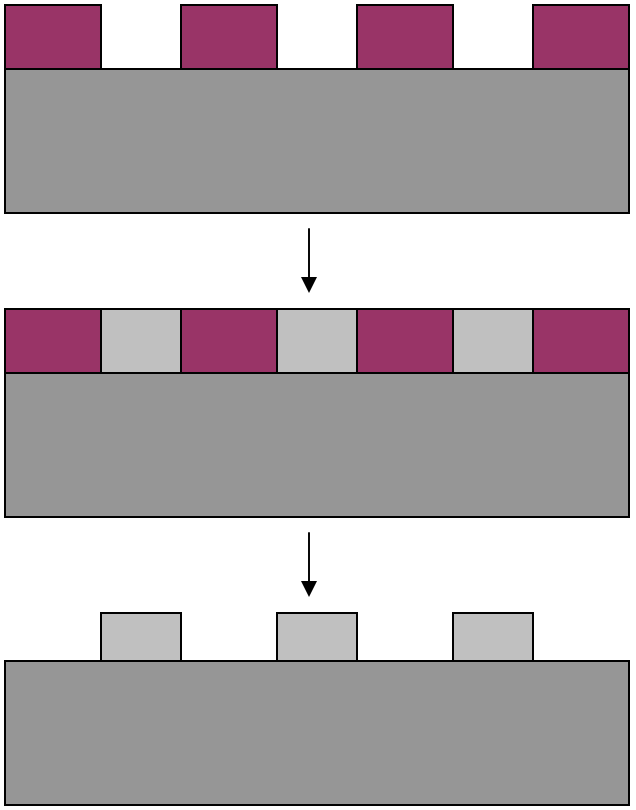
- LIGA Process
  - LIGA Mask Fabrication
  - LIGA Substrate Preparation
  - X-Ray Exposure
  - X-Ray Resist Development
  - Electroplating and Planarization

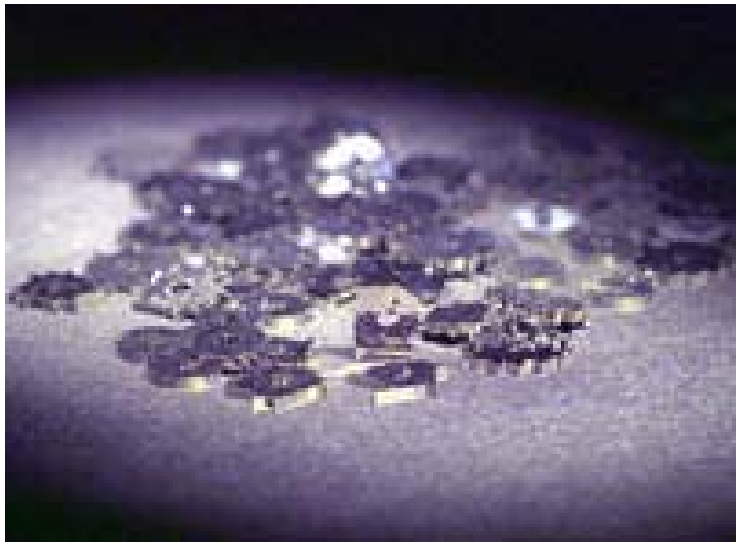
Background



Illustrative Overview

Background

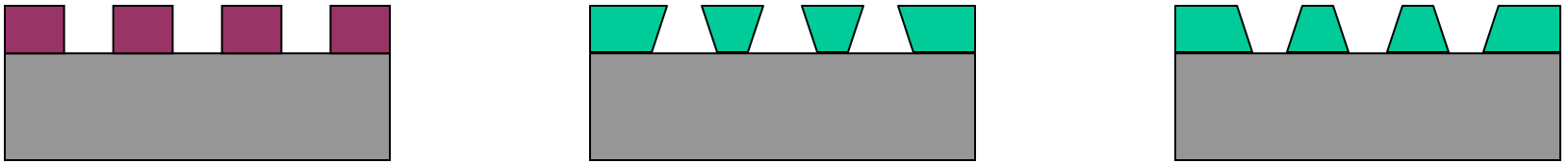


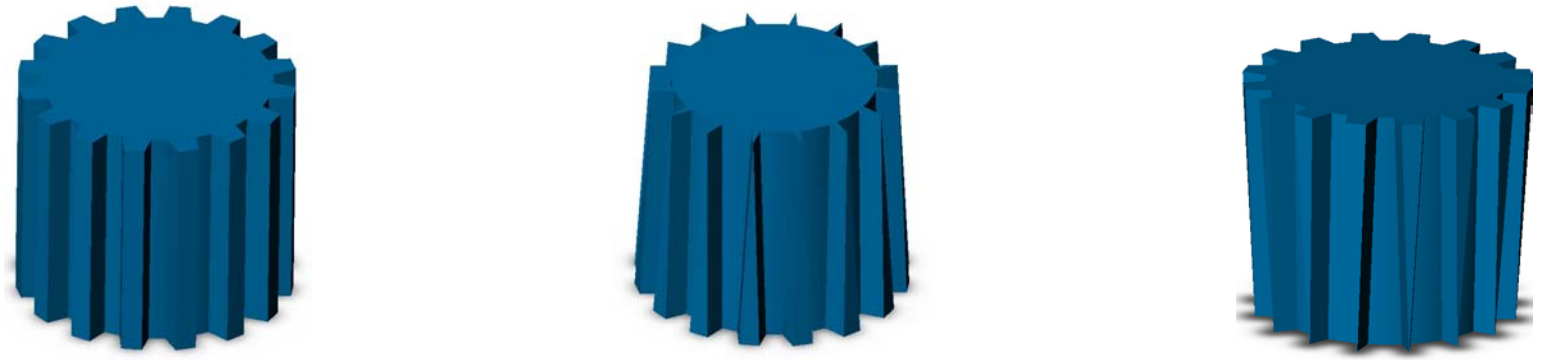


Illustrative Overview

LIGA Problems

- Various geometry outcomes due to overexposure, development, and post-processing





Ideal Overcut Undercut

LIGA Metrology

- Currently, no suitable 3-D data acquisition techniques for part verification
- Difficult to determine sidewall characteristics of high-aspect ratio parts
- Most analyses of parts come from 2-D acquisition methods

LIGA Metrology

- Current 2-D techniques
  - SEM
  - Traditional optical microscopy
  - Stylus profilometry
- Proposed 3-D techniques
  - White-light interferometry
  - Atomic force microscopy
  - Digital volumetric imaging
  - X-Ray tomography
  - Micro-interferometry

LIGA Metrology

- 2-D limitations
  - Only captures 2-D data
  - Relies heavily on image processing
    - Edge detection errors
    - Focus errors
    - Lens aberrations

LIGA Metrology

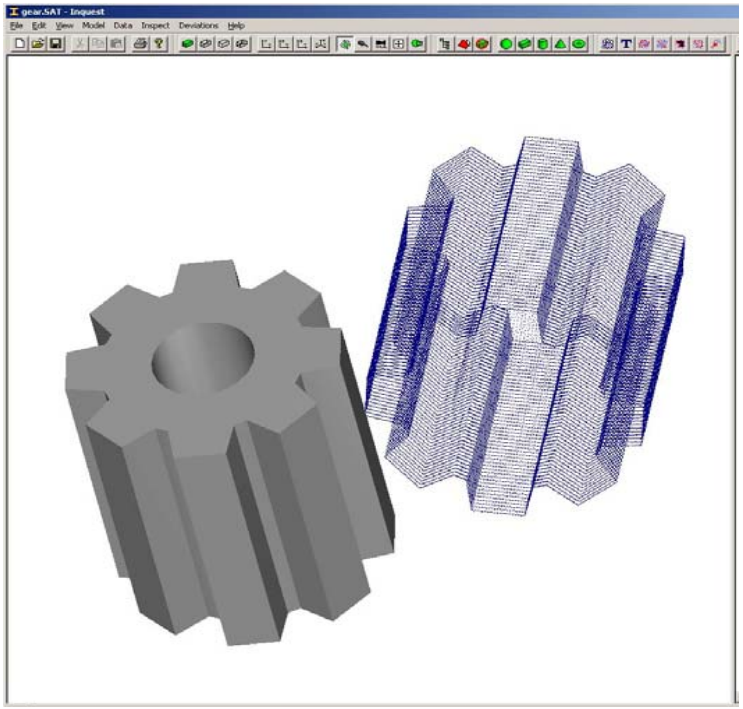
- Issues with proposed 3-D methods
  - White light interferometry – limited to relatively flat surfaces
  - Atomic force microscopy – lack of Z-range and slow
  - Digital volumetric imaging – destructive and post-processing errors
  - X-Ray tomography – resolution and post-processing errors
  - Micro-interferometry – technology not quite there yet

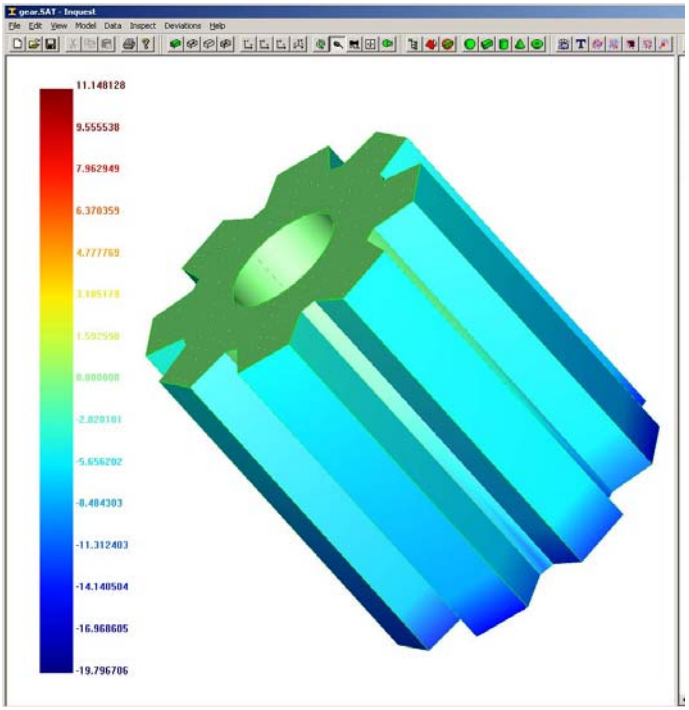
Proposed Research

- Find artifacts of known dimensions that can be analyzed by most of the proposed 3-D analysis methods and exhaustively compare
- Develop LIGA test structures which will allow for thorough comparison of 2-D and 3-D techniques
- Develop software which can analyze both 2-D and 3-D data sets in one environment
- Develop methodology to correctly qualify the LIGA process
- Use methodology to improve process parameters of the fabrication method

Current Status

- Developing software package to analyze both 2-D and 3-D CAD models and pointclouds





Expected Contributions

- Robust software program to analyze 2-D and 3-D data sets
- Reliable methodology to inspect high-aspect ratio MEMS devices
- Improve fabrication steps by “closing the loop” in the manufacturing process